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# ”2-D or not 2-D, that is the question: A Northern California test”

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## Abstract

Reliable estimates of the seismic source spectrum are necessary for accurate magnitude, yield, and energy estimation. In particular, how seismic radiated energy scales with increasing earthquake size has been the focus of recent debate within the community and has direct implications on earthquake source physics studies as well as hazard mitigation. The 1-D coda methodology of *Mayeda et al.* [2003] has provided the lowest variance estimate of the source spectrum when compared against traditional approaches that use direct *S*-waves, thus making it ideal for networks that have sparse station distribution. The 1-D coda methodology has been mostly confined to regions of approximately uniform complexity. For larger, more geophysically complicated regions, 2-D path corrections may be required. The complicated tectonics of the northern California region coupled with high quality broadband seismic data provides for an ideal “apples-to-apples” test of 1-D and 2-D path assumptions on direct waves and their coda. Using the same station and event distribution, we compared 1-D and 2-D path corrections and observed the following results: (1) 1-D coda results reduced the amplitude variance relative to direct *S*-waves by roughly a factor of 8 (800%); (2) Applying a 2-D correction to the coda resulted in up to 40% variance reduction from the 1-D coda results; (3) 2-D direct *S*-wave results, though better than 1-D direct waves, were significantly worse than the 1-D coda. We found that coda-based moment-rate source spectra derived from the 2-D approach were essentially identical to those from the 1-D approach for frequencies less than ~0.7-Hz, however for the high frequencies ($0.7 \le f \le 8.0$-Hz), the 2-D approach resulted in inter-station scatter that was generally 10-30% smaller. For complex regions where data are plentiful, a 2-D approach can significantly improve upon the simple 1-D assumption. In regions where only 1-D coda correction is available it is still preferable over 2-D direct wave-based measures.

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